

Analysis of Regional Economic Differences Based on DEA

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Abstract: This paper introduces the basic principle of data envelopment analysis (DEA), the rating effectiveness of regional investment in China is evaluated on the basis of putting forward the evaluation method of DEA rating effectiveness, and makes a regression analysis of the influencing factors of the rating effectiveness of regional investment in China. Finally, proposes countermeasures according to the factors affecting the effectiveness of investment.

1. Introduction

The regional economy in China has been developing unevenly for a long time. With the promulgation of the national strategic regional planning, the new decade of the western great development has been delineated. In the past one or two years, regional economic planning has been promulgated one by one. The eight economic circles have been delineated one after another, such as the Yangtze River Delta, the Pearl River Delta and the Bohai Rim. The thirteen regional development plans have been on the agenda. Therefore, the analysis of the efficiency of regional economic development has great significance to the study of regional economic problems and the formulation of relevant policies.

There are many methods to evaluate efficiency, such as free distribution analysis method (DFA), stochastic frontier approach (SFA), thick frontier analysis method (TFA), free disposal hull (FDH), data envelopment analysis method (DEA). There are many prominent advantages of DEA model, such as it can deal with decision-making units of multi-input and multi-output without knowing the specific production function. The weight of DEA model are generated by mathematical programming according to data. There is no need to set the weight of input and output in advance, so it is not affected by subjective factors and suitable for the efficiency evaluation of regional complex economies. Comparative analysis, sensitivity analysis and efficiency analysis between target value and actual value can be carried out by applying DEA. The use of resources in decision-making units can be known further. It can be used as a reference for managers' business decisions. Therefore, the author adopts DEA model to measure the efficiency of regional economic development in our country.

2. The Difference of Regional Economic Growth in China

It is not difficult to find the following characteristics through understanding the per capita GDP and the annual growth rate of per capita GDP of China's provinces, cities and autonomous regions, and the ranking of each region in China: after decades of development, the absolute level of per capita GDP in the top three provinces ranking has not changed at all. Among the last 10 provinces in the absolute level of per capita GDP ranking, most provinces are still in the backward rank, but the ranking has increased. Compared with the past, the gap between east and west is greater. Now eastern provinces and cities rank the higher per capita GDP generally, while the western provinces and cities rank the lower per capita GDP generally. The top ten provinces and cities in the per capita GDP ranking are all in the east, the per capita GDP in the east occupy the top rank, but the per capita GDP of provinces in the west which were originally in the top ranking in the past (such as Qinghai,

Gansu, Ningxia and Shaanxi) has rapidly declined. The eastern region develops relatively fast, while the western region develops relatively slow. In sum, the per capita GDP growth rate of all provinces, municipalities and autonomous regions in China is very high both in the past and now. The economic growth of backward provinces has generally accelerated, and the economic growth of provinces with higher per capita GDP has generally slowed down. The income gap tends to narrow. China's rapid economic development is common. As far as the speed of development is concerned, the regions with high income level are lower than those with low income level, and the backward regions are generally catching up with the advanced regions.

3. DEA Model for Measuring Economic Efficiency in Different Regions

Data envelopment analysis (DEA) was proposed by famous American management science experts Charnes, Cooper and Rhodes (1978) [6], which is a common linear programming method in the evaluation of organizational efficiency. The DEA model can calculate the efficiency frontier under entering certain input and output indicators, that is the production frontier composed of the frontier production area consists of maximizing output under fixed inputs or decision-making units (DMU) of minimizing cost under fixed outputs. The distance between the decision-making unit to be inspected and the decision-making unit of the efficiency frontier is the relative efficiency of the decision-making unit. DEA belongs to non-parametric method. Compared with parametric methods in frontier analysis, such as stochastic frontier analysis (SFA) and free distribution analysis method (DFA), DEA can be used for different dimension indicators. It does not need to set specific function forms to determine the efficiency frontier subjectively, nor does it need to assign relative weight to the indicators subjectively, with strong objectivity. In view of the above, this paper uses DEA model to measure the economic efficiency of different regions. Let X_{mj} be the input level of "m"th factor of the "j"th province, $m=\{1, \dots, M\}$; Y_{nj} represents the nth output level of the "j"th province, $n=\{1, \dots, N\}$; separately note $X_j=(X_{1j}, \dots, X_{mj})$ as the input vector of the "j"th province, $Y_j=(Y_{1j}, \dots, Y_{nj})$ is the output vector of the "j"th province. The input-oriented DEA model is used to measure regional economic efficiency.

$$\min_{\theta, \lambda} \theta$$

$$\text{s.t.} \quad \theta X_{j_0} - \sum_{j=1}^J \lambda_j X_j \geq 0$$

$$-Y_{j_0} + \sum_{j=1}^J \lambda_j Y_j \geq 0$$

$$\sum_{j=1}^J \lambda_j = 1 \quad \lambda_j \geq 0, j = 1, 2, \dots, J'$$

Among them, λ_j is the weight coefficient, θ is the objective value, and the optimal solution θ^* can be obtained according to the linear programming technology. If the optimal solution of a region is $\theta^*=1$, it shows that the production efficiency of the region is good and can organize production and control cost in an efficient way. Otherwise, the production of the region is relatively inefficient.

Among the traditional literature of using DEA model to study regional productivity differences, the selection of input-output indicators all regard the gross domestic product of each region as output indicators, capital and labor as input indicators, while neglect the environmental pollution which associated with economic output (GDP) tightly. Therefore, in order to accurately investigate the comprehensive production efficiency of each region, the environmental cost of economic growth must be included in the efficiency evaluation system. In view of the above, this paper defines the ratio of GDP and environmental pollution index in each region as the relative green GDP of each region, and brings it as an output index into DEA model of economic efficiency

measurement. The comprehensive index of regional environmental pollution constructed by the TOPSIS. The relative green GDP reflects the GDP per unit of environmental pollution. The larger the proportion, the smaller the environmental cost of economic growth in the region. Otherwise, the production in the region is ineffective from the perspective of eco-economy. Therefore, using relative green GDP as output index to measure the ability of each region to realize factor input and minimize environmental pollution under the fixed output, that is the green economic efficiency of each region. In addition, according to Solow's economic growth model: $Y = F(K, L, A)$, besides capital and labor, there are also technological inputs in the input factors of the economy. Each province uses a certain mode of production (technology) to convert capital and labor into output. Therefore, as a production factor, technology should also be included in DEA model as an input index. Accordingly, the final output index selected in this paper is the relative green GDP of each province, and the input index is capital, labor and technology investment. The green GDP of each province is calculated by the pollution integrated index ENV and total output value of each region. The data of regional total output value are directly derived from the China Statistical Yearbook (1995-2008), and obtained by the deflation of consumer price index (CPI) in each region. The index of labor input is the number of employees in each region at the end of the year, the number of patents authorized by each region at the end of the year is the amount of technology input, these data are from China Science and Technology Statistical Yearbook (1995-2008). Due to the lack of publicly available regional capital stock data, this paper uses the perpetual inventory method to estimate the capital stock in each region and takes it as the index of regional capital investment. The concrete formulas are as follows:

$$K_{i,t} = K_{i,t-1}(1 - \delta_{i,t}) + I_{i,t} / P_{i,t}$$

Among these, $K_{i,t}$ and $K_{i,t-1}$ are the capital stock of the "i"th province and city in the "t" and "t-1" periods respectively; $\delta_{i,t}$, $I_{i,t}$ and $P_{i,t}$ are the depreciation rate, the total investment in the year and the investment price index of the "i"th province in the "t" period. Zhang Jun et al. (2004) [7] estimate the capital stock data of 30 provinces and municipalities in China from 1952 to 2000 by using the perpetual inventory method on the basis of carefully dealing with and studying the capital stock, price index of investment products, selection and determination of depreciation rate in the base year; which provided scientific data support for the study of regional economic growth and total factor productivity. According to Zhang Jun et al. (2004) estimation method and the capital stock data of 1995 provinces and urban areas calculated by Zhang Jun et al. (2004) as the base year capital stock, this paper estimates the capital stock in sample provinces from 1995 to 2007 according to formula (6) and take it as the capital input data.

4. Conclusion and Suggestion

This paper analyses the economic data of China in 2012 and shows that there are more regional investments in China that fail to achieve DEA efficiency, and the coastal regions are still the regions in China which have better regional economic development, while the investment efficiency in the central and western regions has improved, especially in the northwest. The phenomenon of diminishing scale merit in coastal regions has been slightly improved. Most of the northwest regions are in the stage of increasing scale merit, and the national regional economic policies have achieved results.

However, there is still a long way to go for the coordinated development of the region. While increasing the investment, we must further explore the factors affecting the effectiveness of investment and seek countermeasures.

First, the reform of regional investment system should be strengthened. At present, most of the investment activities are managed by the state, but with the continuous development of market economy and diversification of investment channels, the regional investment system will also be in line with the market and take the road of high efficiency.

Second, the funds should be guided from the over-concentrated eastern coast to the central

and western regions. On the one hand, direct investment in the central and Western regions should be strengthened; on the other hand, more preferential regional investment policies to encourage investment in the western regions should be formulated and increase employment channels and jobs.

Third, the role of science and technology in the economic growth of the western region should be vigorously improved. Science and technology are the first productive forces. The high-tech achievements in advanced areas should be rationally transformed, and focus on improving the professional skills and management level of employees, improving production efficiency and promoting development with efficiency.

Moreover, the driving role of coastal areas in the effective development of China's economy should not be neglected while developing the western region. We should further improve the utilization rate of funds in order to reduce input and increase output.

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